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EDİTÖRE MEKTUP / LETER TO THE EDITOR

MAY THE HONEY BEES SENSITIVITY TO EARTH'S MAGNETIC FIELD ASSIST THEM FOR BUILDING?

Bal Arılarının Dünyanın Manyetik Alanına Duyarlılığı Yapımda Yardımcı Olabilirmi?

Alexander P. POKUTSA[1*] and Jacques MUZART[2B]

[1*]Institute of Physical Organic Chemistry and Chemistry of Coal NAS of Ukraine, Department of Physical Chemistry of Fossil Fuels, Naukova Str., 3A, Lviv 79060, UKRAINE, Corresponding author E-mail: apokutsa@ukr.net; ORCID No.: 0000-0001-5564-1997

[2] Institut de Chimie Moléculaire de Reims, UMR 6229, UFR des Sciences Exactes et Naturelles, CNRS - Université de Reims Champagne-Ardenne BP 1039, 51687, Reims Cedex 2, FRANCE, E-mail: jacques.muzart@univ-reims.fr; ORCID No: 0000-0002-1276-4206

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ABSTRACT

A surprising D_{12} symmetry inside-hive constructions of honey bees were disclosed. The well-established sensitivity of bees to the magnetic field led us to supposition that it may play a key role in steering of such regular architecture.

Key Words: Magnetic field, *Apis mellifera carpatica,* Magnetic sensitivity, Inside-hive orientation, Uncommon architecture

ÖZ

Bal arılarının şaşırtıcı bir D12 simetrisi kovan içi yapıları açıklandı. Arıların manyetik alana karşı köklü duyarlılığı, bu tür düzenli mimarinin yönlendirilmesinde anahtar bir rol oynayabileceğini varsaymamıza neden oldu.

Anahtar Kelimeler: Manyetik alan, *Apis mellifera carpatica,* Manyetik hassasiyet, Kovan içi orayantasyon, Sıra dışı mimari

Gould and co-workers (1978) discovered the ability of the bees to feel subtle variations of the magnetic field. Gries's team demonstrated the honeybees sensitivity to the polarity of magnetic field (Lambinet et al. 2017) owing to the magneto-receptor located in their abdomens (Walker and Bitterman 1985, Liang et al. 2016). Such property of natural selection enables bees navigation in the opened environment and was intensively studied for decades mainly in that context (Gould, et al. 1980, Walker et al. 1989, Ferrari 2014). Nevertheless, as appeared, the established skills could also explain the revealed recently bees' behavior related to the unusual inner-hive engineering. In addition, the observations presented herein also supports the earlier expressed suggestions concerned the behavioral flexibility of honey bees which, on the other hand, may reflect their cognitive skills including individual recognition and observational learning (Tsvetkov et al. 2019, Feinerman and Korman 2017).

A few years ago, one of us (AP) fed his colonies of *Apis mellifera carpatica* (49°34' N, 22°47' E, Eastern Beskids, Ukraine) with sugar syrup poured in plastic feeders placed inside six hives The feeders possess twin truncated cones, each surmounted with a 90 mm top diameter cup (Fig. 1, S1, S2). A 70 mm diameter hole at the base of each cone affords to the bee a safety round-trip from the hive to the syrup source (Fig. 1, S2). After two weeks, the examination of feeders led to a surprising observation. The edge of each cup of one of the feeder was glued to the feeder's bottom by propolis gobs, distinctly charting two perfect dodecagons symmetric to each other (Figures 1, 2, S1 and S2).

Despite the 115 mm distance between the centers of these regular dodecagons and shielding from each other by the walls of the plastic cups (Fig. S2), the figures (dihedral group D_{12} of order 24) created by propolis gobs were identical and furthermore mirror-image symmetrical (Figures 1, 2 and S1). The shape of these structures was unusual, differing from the regular hexagons (dihedral group D_6 of order 12) commonly constructed by the bees. Moreover, the direction of imaginary secant lines connecting the respective opposite propolis gobs coincide with the cardinal points (Fig. 2).

We assume that the architecture leading to formation of two symmetrical dodecagons arose from the bee sensitivity to the local geomagnetic field fluctuation (Liang et al. 2016). For example, the lines connecting the pairs of propolis gobs marked *ab* (left cone) and *a'b'* (right cone) are parallel and coincide with the N-S cardinal points. Remarkably, the other connecting lines (e.g. *cd, ef* and *gh* as well as *c'd', e'f'* and *g'h'*) create sectors with identical angles of 30° (Fig. 2). Such constructions, although not so evident, have been detected also from our other hives. For example, by inspection the manner by which the plastic cups were glued to the bottom of others feeders, one can discern the shapes of regular dodecagons too (Fig. S3).

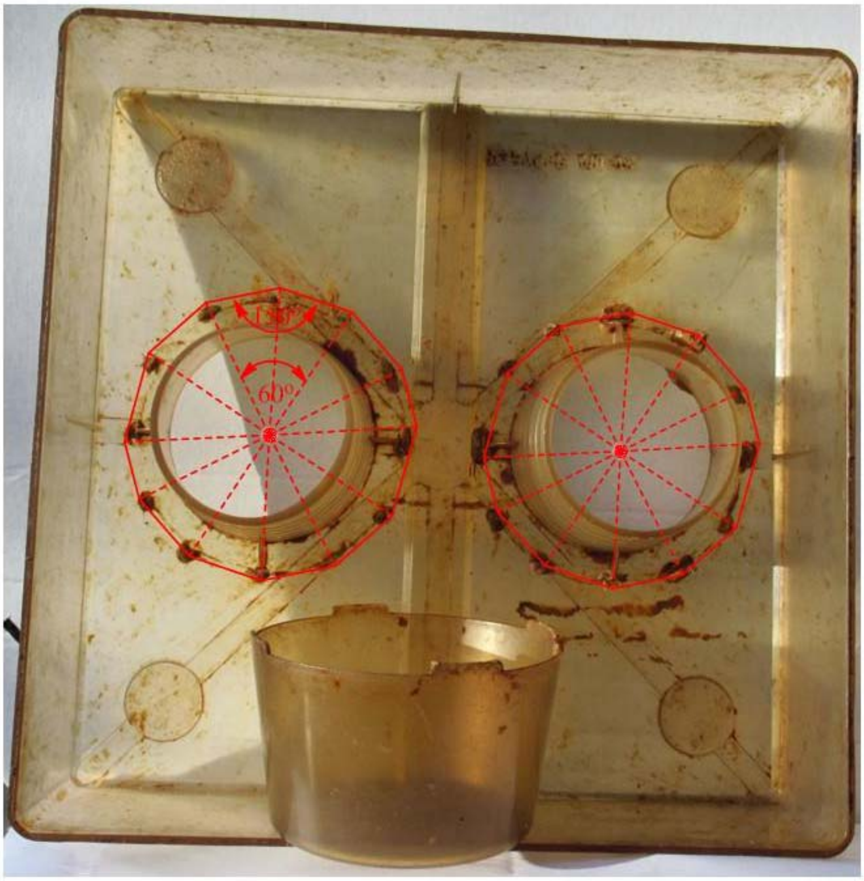

Fig. 1. The propolis gobs (brown patches) around the bottom border of the plastic truncated cones chart two regular dodecagons (red closed chains). For clarity, the cups which covered the cones (the formers were fixed by the gobs to the feeder's bottom) were disconnected and one of them was placed in the front of the feeder.

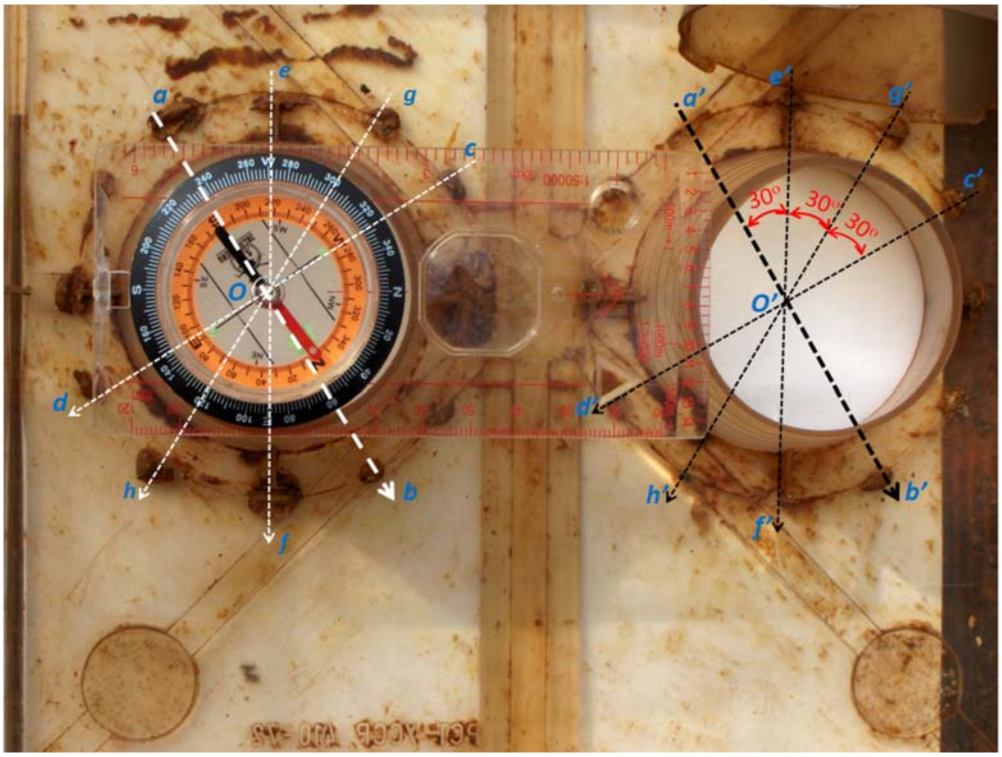

Fig. 2. Photo of the feeder with a compass over the left truncated cone. The secant *ab*, and *a'b'* dash-lines coincide with the Nord-South direction.

As we supposed, the circumstance furthered the developing of the revealed feature was, among others, the location of apiary in the rural region far from the facilities able to generate the electromagnetic field (i.e. radio, television or cell tower antennas, high-voltage lines, radar or satellite stations, etc. For instance, the shortest distance from the nearest cell tower to the colony was more than 2 km). The enlisted factors may be a crucial in view of impact on the bees behavior. According to Kirschvink et al. (19917) and Abou-Shaara (2018) investigation, honeybees are able to detect static intensity fluctuations as weak as 26 nT against the earth-strength magnetic field. Rendering of that the local magnetic anomalies may impact not only the bees navigation in the open environment, but predictively, inside the hive too. Elimination of such effect down to zero (i.e. placing the colony far away from any sources of artificial magnetic fields) enables the bees to follow of their natural engineering skills. And the last ones presumably assist them to construct the exciting figures were exhibited by this research. On the other hand, revealed constructional behavior of the honeybees presumably reflects not only the instinct activity but may be a result of their ingenuity and engineering prowess (Gallo and Chittka 2018, Nazzi 2016). For example, considering that the immobilization of regular large object (in our case the circle-shaped edge of cup) demands to use the figure with number of angles higher than six, they chosen the dodecagon-shaped one. The intra-hive orientation of the bees by their magnetoreceptors may please the execution of the last operation, what was actually demonstrated with this study.

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